

U.S. Hydropower Resource Assessment for Minnesota

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ABSTRACT

The U.S. Department of Energy is developing an estimate of the undeveloped hydropower potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. HES measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report describes the resource assessment results for the State of Minnesota.

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INTRODUCTION

In June 1989, the U.S. Department of Energy initiated the development of a National Energy Strategy to identify the energy resources available to support the expanding demand for energy in the United States. Public hearings conducted as part of the strategy development process indicated that undeveloped hydropower resources were not well defined. As a result, the Department of Energy established an interagency Hydropower Resource Assessment Team to ascertain the undeveloped hydropower potential. In connection with these efforts by the Department of Energy, the Idaho National Engineering Laboratory designed the Hydropower Evaluation Software (HES), which has been used to perform a resource assessment of the undeveloped conventional hydropower potential in over 30 states. This report presents the results of the hydropower resource assessment for the State of Minnesota. Undeveloped pumped storage hydropower potential is not included.

The HES was developed as a tool to measure undeveloped hydropower potential regionally or by state. The software is not intended to provide precise development factors for individual sites, but to provide regional or state totals. Because the software was developed as a generic measurement tool encompassing national issues, regional and state totals must be considered judiciously; various local issues may skew undeveloped hydropower potential totals. The information for the resource assessment was compiled from the Federal Energy Regulatory Commission's Hydroelectric Power Resources Assessment database and several other sources. Refer to DOE/ID-10338, the *User's Manual* (Francfort, Matthews, Rinehart 1991) for the specifics of the software and to DOE/ID-10430.1, the *Status Report* (Conner, Francfort, Rinehart 1996) for an overview of all resource assessment activities to date.

Model Development

Hydropower Evaluation Software, both a probability-factor computer model and a database, is a menu-driven program that is intended to be user-friendly. Computer screens and report-generation capabilities were developed to meet the needs of users nationwide. The software uses environmental attribute data for each potential site to generate an overall project environmental suitability factor (PESF) between 0.1 and 0.9. The PESF reflects the considerations that (a) environmental concerns can make a potential site unacceptable, prohibiting its development (for a suitability factor of 0.1), or (b) if there are no environmental concerns, there is a higher likelihood of site development (0.9 indicating the highest likelihood of development). A combination of attributes can result in a lower suitability factor because multiple environmental considerations would reduce the likelihood that a site may be developed to its physical potential.

Model Goal

The goal of the HES is to assemble an accurate resource database of all sites with undeveloped hydropower potential in the United States for use as a planning tool to determine the viable national hydropower potential. Undeveloped hydropower potential is not limited to the development of new sites; it also includes the development of additional hydropower-generating capacity at sites that currently have hydropower, but are not developed to their full potential. This undeveloped hydropower potential is a source of nonpolluting, renewable energy available to meet the growing power needs of the United States. The HES should help make this goal obtainable and ensure a set of uniform criteria for national assessment.

Dam Status

The effects of environmental attributes vary by dam status. The dam status classifications used in

the resource assessments (see Appendices) are as follows:

- W = Developed hydropower site with current power generation, but the total hydropower potential has not been fully developed. Only the undeveloped hydropower potential is discussed in this report.
- W/O = Developed site without current power generation. The site has some type of developed impoundment or diversion structure, but no developed hydropower generating capability.
- U = Undeveloped site. The site does not have power generation capability nor a developed impoundment or diversion structure.

ASSESSMENT RESULTS

Summary Results

A total of 40 sites (Table 1) have been identified and assessed for their undeveloped hydropower potential. The HES results for individual site capacities range from 1 kilowatt (kW) to 48 megawatts (MW). Most of the HES-modeled sites in Minnesota are small hydropower sites (only one individual site is larger than 15 MW). In fact, 60%

of the sites have individual site capacities of less than 1 MW each (Figure 1).

The nonmodeled undeveloped hydropower potential total for Minnesota was identified as 226 MW. The HES results lowers this estimate about 40% to 136 MW. The greatest reduction in undeveloped hydropower potential, by MW, occurs at sites with no structures in place (undeveloped category). These sites have an HES-modeled undeveloped hydropower potential of 14 MW, a 41 MW reduction in the estimated undeveloped hydropower potential (Figure 2). The developed sites, with power, have the lowest percentage decrease in modeled undeveloped potential capacity. The unadjusted potential is 98 MW, and the modeled capacity is 72 MW, a 27% decrease in capacity (Figure 2). As can be deducted from Figure 3, the undeveloped sites have the smallest HES-modeled average capacity per site (2.0 MW), and the developed sites with power have the highest HES-modeled average capacity per site (5.9 MW). Figure 4 illustrates a developed site at the St. Cloud Dam.

The 40 identified sites are located within 8 major river basins and several minor river basins. The number of sites per river basin range from 1 in several major rivers basins to 14 sites in the Mississippi River Basin (Figure 5). The St. Louis River Basin has the most undeveloped hydropower potential (60 MW) of the Minnesota river basins (Figure 6).

Table 1. Undeveloped hydropower potential summaries for Minnesota. The table contains the nonmodeled undeveloped nameplate potential and the HES-modeled undeveloped hydropower potential totals.

	Number of projects	Nameplate potential (MW)	HES-modeled potential (MW)
With Power	12	98.0	71.5
W/O Power	21	73.2	51.1
Undeveloped	7	54.7	13.9
State Total	40	225.9	136.5

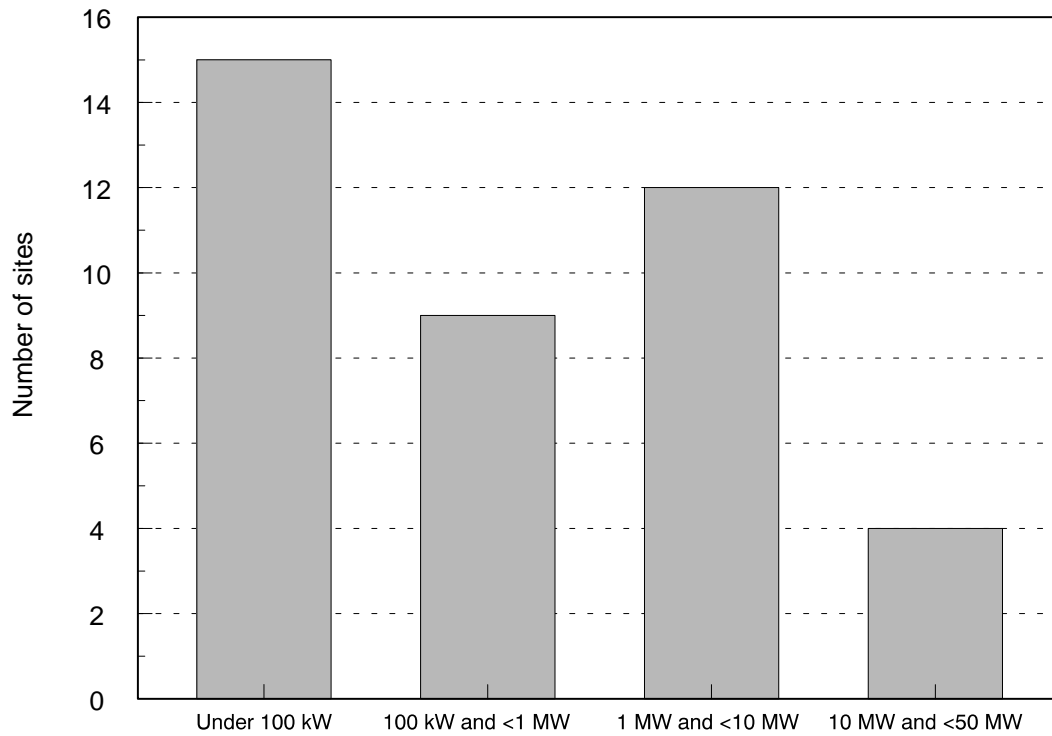


Figure 1. Number of sites, by capacity groups, with HES-modeled undeveloped hydropower potential.

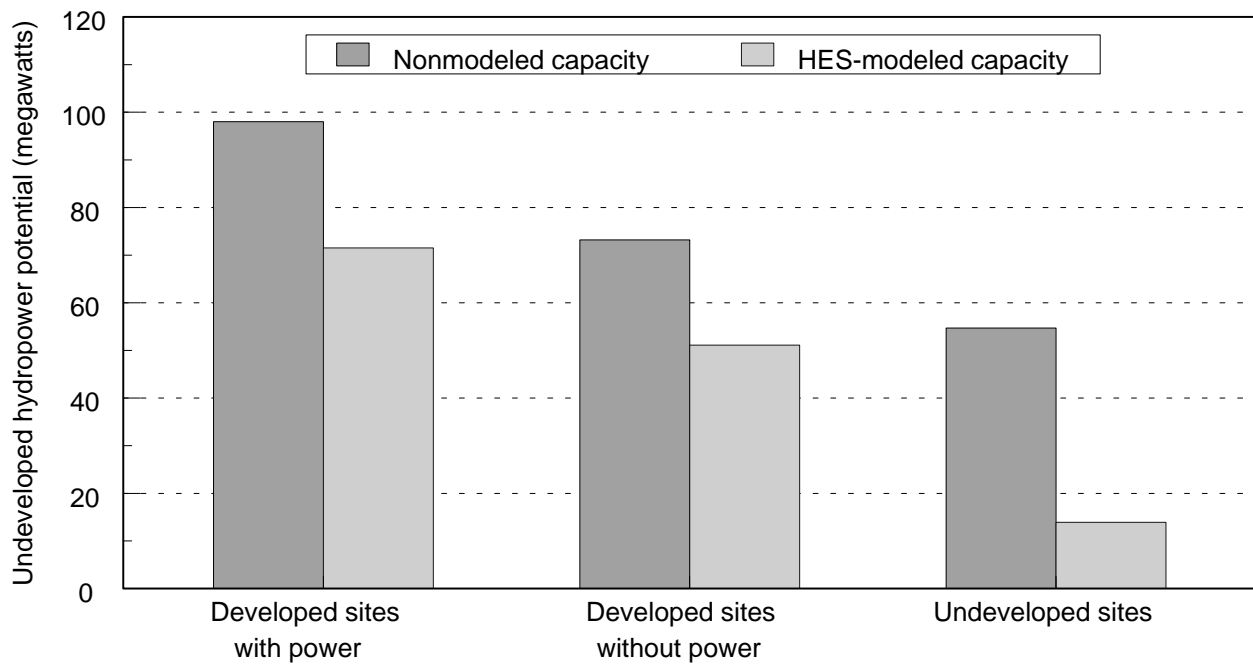


Figure 2. The nonmodeled and HES-modeled undeveloped hydropower potential.

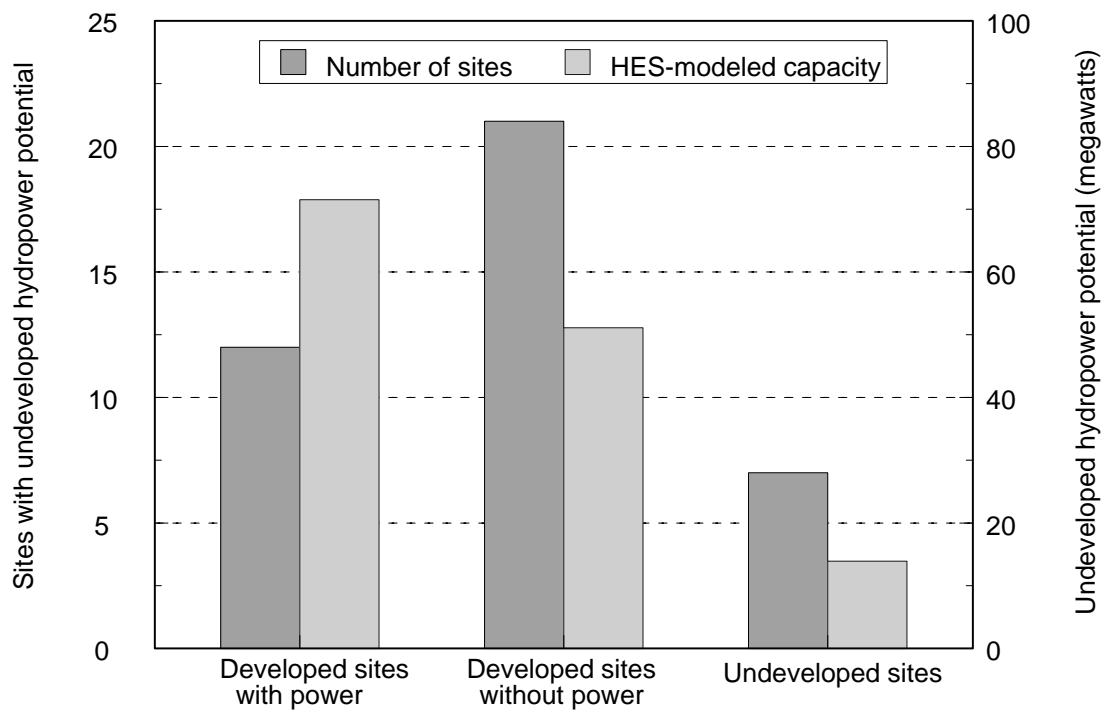


Figure 3. The number of sites with undeveloped hydropower potential and the total megawatts of HES-modeled undeveloped hydropower potential.

Figure 4. Example of a Minnesota undeveloped site that was subsequently developed. The site, at the St. Cloud Dam (FERC 04108) on the Mississippi River, has a current capacity of 8 megawatts and annually produces about 42,000 megawatt-hours of energy.

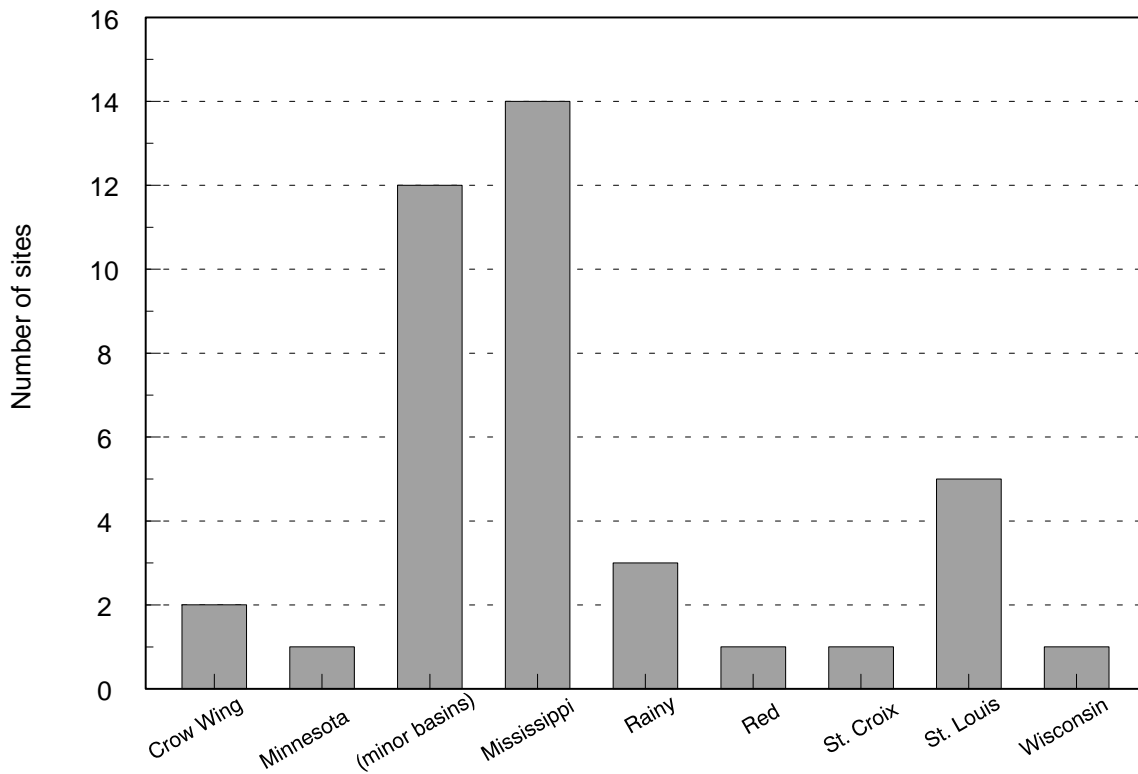


Figure 5. Number of sites with undeveloped hydropower potential in the Minnesota river basins.

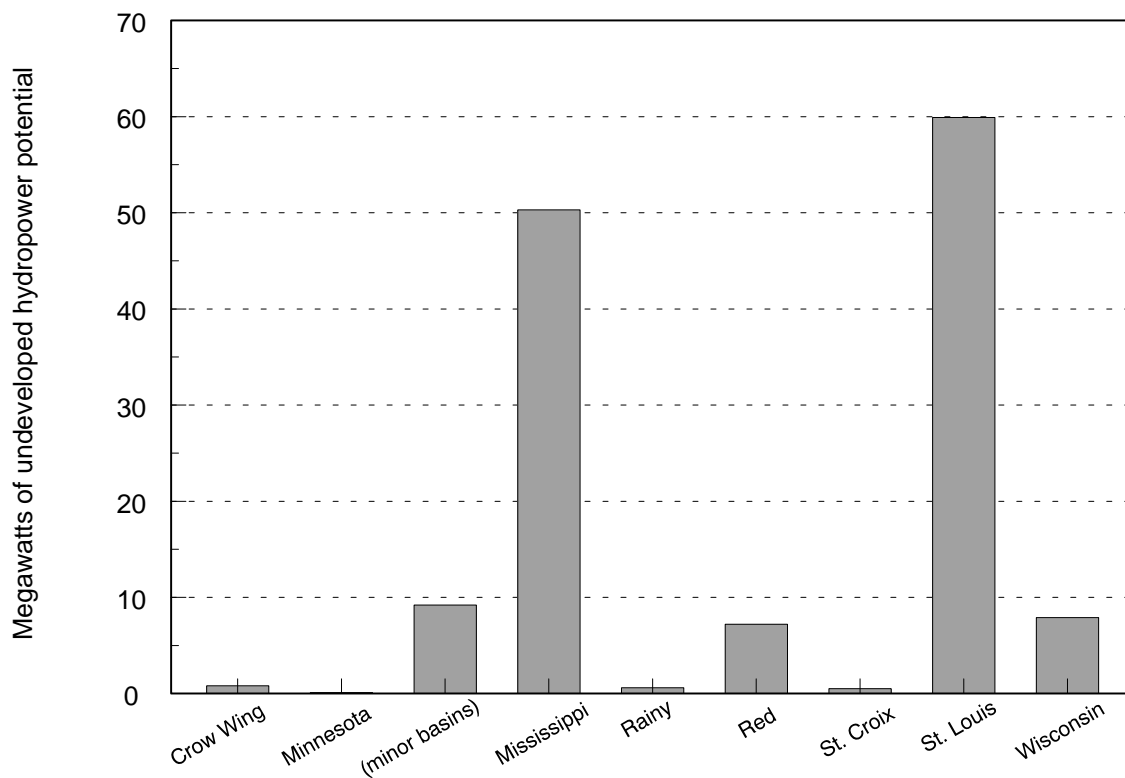


Figure 6. Megawatts of HES-modeled undeveloped hydropower potential in the Minnesota river basins.

Detailed Results

The appendices contain, in the form of HES-generated reports, detailed information about the undeveloped hydropower potential in Minnesota:

Appendix A lists the undeveloped hydropower potential by dam status groups. It includes the number of sites, nonmodeled undeveloped hydropower potential, and HES-modeled undeveloped hydropower potential.

Appendix B contains the hydropower resource assessment by river basin. For each site, it includes the project number, project name, stream name, dam status, nonmodeled undeveloped hydropower potential, and the HES-modeled undeveloped hydropower potential. Subtotals are provided for each river basin.

Appendix C lists the project numbers, plant name, stream name, if a site is Federally owned, nonmodeled undeveloped hydropower potential, and HES-modeled undeveloped hydropower potential. The sites are grouped by dam status.

Appendix D contains a resource database list for each of the 40 sites in Minnesota. Information includes plant name, stream, state, county, river basin and owner names, project number, name plate and HES-modeled undeveloped hydropower potential, the unit and plant types, dam status, latitude, longitude, and the environmental factors that the HES uses to determine the project environmental suitability factor.

OBTAINING INDIVIDUAL STATE INFORMATION

Additional copies of the hydropower resource assessment results for individual states are available and can be obtained by writing or calling the authors or the National Technical Information Service (NTIS).

Telephone Orders—(703) 487-4650. NTIS sales desk and customer services are available

between 8:30 a.m. and 5:00 p.m., Eastern Standard Time.

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For Help in Tracing an Order—Call (703) 487-4650 and request the customer service option.

ADDITIONAL HYDROPOWER EVALUATION SOFTWARE INFORMATION

Additional information concerning the HES can be obtained by contacting Ben Rinehart or Jim Francfort at the addresses provided below. Copies of the software and the User's Manual may also be obtained from these individuals.

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Information concerning the State of Minnesota's involvement with the resource assessment or about the identified sites may be obtained by contacting:

Richard Hvelsinki
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121 7th Place East, Suite 200
St. Paul, Minnesota 55101-2145
(612) 296-7107

REFERENCES

- Francfort, J. E., S. D. Matthews, and B. N. Rinehart, 1991, *Hydropower Evaluation Software User's Manual*, DOE/ID-10338, Idaho National Engineering Laboratory, Idaho Falls, Idaho.
- Conner, A. M., J. E. Francfort, and B. N. Rinehart, 1996, *Uniform Criteria for U.S. Hydropower Resource Assessment, Hydropower Evaluation Software Status Report-II*, DOE/ID 10430.1, Idaho National Engineering Laboratory, Idaho Falls, Idaho.